MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2017/2018

DCA5068 – FIELD THEORY

(Diploma in Electronic Engineering)

1 JUNE 2018
3:00 PM – 5:00 PM
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of **5** pages (**4** pages with **4** questions and **1** page for appendix).

2. Answer **ALL** questions. All necessary working steps must be shown.

3. Write all your answers in the answer booklet provided.

QUESTION 1 [25 Marks]

a) Given vector $\vec{A}$ is directed from point W = (5,3,-9) to point X = (7,-3,2) and vector $\vec{B}$ is directed from point Y = (2,1,7) to point Z = (-2,3,8). Calculate:

i) Vector $\vec{A}$ and $\vec{B}$.

[2 marks]

ii) $\vec{A} \bullet \vec{B}$.

[2 marks]

iii) $5\vec{A} - 2\vec{B}$.

[2 marks]

iv) $7(\vec{A} \times \vec{B})$.

[4 marks]

v) $|\vec{A}|$ and $|\vec{B}|$.

[2 marks]

vi) Unit vector, $\hat{a}$.

[2 marks]

vii) The angle between vector $\vec{A}$ and $\vec{B}$.

[3 marks]

b) Transform the following vector to cylindrical coordinate system at the indicated point:

$$\vec{A} = 7\hat{\imath} + 5\hat{\jmath} \text{ at N(x = 3, y = 5, z = 9).}$$

[8 marks]

Continued...

QUESTION 2 [25 Marks]

a) A point charge $Q_1 = 25\ nC$ is located at $P_1(4,-3,8)$ and a second charge $Q_2 = 60\ nC$ is located at $P_2(-3,5,-3)$. Calculate the electric field intensity at $P_3(1,2,3)$.

[8 marks]

b) Referring to Figure 1 below, calculate the total force, F_T exerted on the point charge located at the origin (0,0,0).

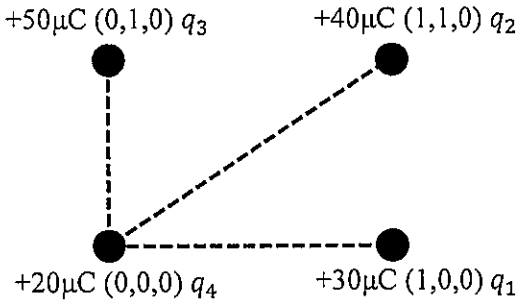

Figure 1

[11 marks]

c) Two capacitors with the value of $C_1 = 30\ \mu F$ and $C_2 = 20\ \mu F$ are connected in series with a voltage supply of 10 V. Calculate:

i) The total capacitance of the circuit combination.

[2 marks]

ii) The potential difference across each capacitor.

[4 marks]

Continued...

QUESTION 3 [25 Marks]

a) The maximum current in a superconducting solenoid can be as large as 3.65 *kA*. If the number of turns per meter in such a solenoid is 4250, calculate the magnitude of the magnetic field that it can produce.

[4 marks]

b) A circular loop in the plane of the paper lies in a 0.7 *T* magnetic field pointing into the paper. If the loop's diameter changes from 40 *cm* to 20 *cm* in 0.60 *s*, calculate the magnitude of the average induced EMF.

[8 marks]

c) An EMF is induced in a conducting loop of wire 3.0 *m* long as its shape is changed from circular to square. Find the average magnitude of the induced EMF if the change in shape occurs in 5.25 *s*, and the local 0.10 *T* magnetic field is perpendicular to the plane of the loop.

[9 marks]

d) Two coils connected in series have a self-inductance of 60 *mH* and 180 *mH* respectively. The total inductance of the combination was found to be 300 *mH*. Determine the amount of mutual inductance that exists between the two coils assuming that they are aiding each other.

[4 marks]

Continued...

QUESTION 4 [25 Marks]

a) Describe **two similarities** and **three differences** between magnetic circuit and electric circuit.

[9 marks]

b) Briefly explain the concept of eddy currents.

[4 marks]

c) Classify which type of transformers is generally used for audio frequency and high frequency applications.

[2 marks]

d) Describe one advantage for each of the core type and shell type transformers.

[4 marks]

e) Explain the concept of reflected load.

[6 marks]

End of Page

FORMULAE

Transformation	Coordinate Variables	Unit Vectors	Vector Components
Cartesian to Cylindrical	$r = \sqrt{x^2 + y^2}$ $\phi = \tan^{-1}(y/x)$ $z = z$	$\hat{r} = \hat{x}\cos\phi + \hat{y}\sin\phi$ $\hat{\phi} = -\hat{x}\sin\phi + \hat{y}\cos\phi$ $\hat{z} = \hat{z}$	$A_r = A_x\cos\phi + A_y\sin\phi$ $A_\phi = -A_x\sin\phi + A_y\cos\phi$ $A_z = A_z$
Cylindrical to Cartesian	$x = r\cos\phi$ $y = r\sin\phi$ $z = z$	$\hat{x} = \hat{r}\cos\phi - \hat{\phi}\sin\phi$ $\hat{y} = \hat{r}\sin\phi + \hat{\phi}\cos\phi$ $\hat{z} = \hat{z}$	$A_x = A_r\cos\phi - A_\phi\sin\phi$ $A_y = A_r\sin\phi + A_\phi\cos\phi$ $A_z = A_z$
Cartesian to Spherical	$R = \sqrt{x^2 + y^2 + z^2}$ $\theta = \tan^{-1}(\sqrt{x^2 + y^2}/z)$ $\phi = \tan^{-1}(y/x)$	$\hat{R} = \hat{x}\sin\theta\cos\phi + \hat{y}\sin\theta\sin\phi + \hat{z}\cos\theta$ $\hat{\theta} = \hat{x}\cos\theta\cos\phi + \hat{y}\cos\theta\sin\phi - \hat{z}\sin\theta$ $\hat{\phi} = -\hat{x}\sin\phi + \hat{y}\cos\phi$	$A_R = A_x\sin\theta\cos\phi + A_y\sin\theta\sin\phi + A_z\cos\theta$ $A_\theta = A_x\cos\theta\cos\phi + A_y\cos\theta\sin\phi - A_z\sin\theta$ $A_\phi = -A_x\sin\phi + A_y\cos\phi$
Spherical to Cartesian	$x = R\sin\theta\cos\phi$ $y = R\sin\theta\sin\phi$ $z = R\cos\theta$	$\hat{x} = \hat{R}\sin\theta\cos\phi + \hat{\theta}\cos\theta\cos\phi - \hat{\phi}\sin\phi$ $\hat{y} = \hat{R}\sin\theta\sin\phi + \hat{\theta}\cos\theta\sin\phi + \hat{\phi}\cos\phi$ $\hat{z} = \hat{R}\cos\theta - \hat{\theta}\sin\theta$	$A_x = A_R\sin\theta\cos\phi + A_\theta\cos\theta\cos\phi - A_\phi\sin\phi$ $A_y = A_R\sin\theta\sin\phi + A_\theta\cos\theta\sin\phi + A_\phi\cos\phi$ $A_z = A_R\cos\theta - A_\theta\sin\theta$
Cylindrical to Spherical	$R = \sqrt{r^2 + z^2}$ $\theta = \tan^{-1}(r/z)$ $\phi = \phi$	$\hat{R} = \hat{r}\sin\theta + \hat{z}\cos\theta$ $\hat{\theta} = \hat{r}\cos\theta - \hat{z}\sin\theta$ $\hat{\phi} = \hat{\phi}$	$A_R = A_r\sin\theta + A_z\cos\theta$ $A_\theta = A_r\cos\theta - A_z\sin\theta$ $A_\phi = A_\phi$
Spherical to Cylindrical	$r = R\sin\theta$ $\phi = \phi$ $z = R\cos\theta$	$\hat{r} = \hat{R}\sin\theta + \hat{\theta}\cos\theta$ $\hat{\phi} = \hat{\phi}$ $\hat{z} = \hat{R}\cos\theta - \hat{\theta}\sin\theta$	$A_r = A_R\sin\theta + A_\theta\cos\theta$ $A_\phi = A_\phi$ $A_z = A_R\cos\theta - A_\theta\sin\theta$

Permittivity of free space, $\varepsilon_o = 8.854\times10^{-12}\,F/m$

Permeability of free space, $\mu_o = 4\pi\times10^{-7}\,T.m/A$